A Short Introduction to Danish Environmental History

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A Short Introduction to Danish Environmental History

by Bo Fritzbøger

What is environmental history?

Numerous suggestions have been made to define environmental history. Some focus on historical changes in the physical environment. Others upon human adaption to or modification of our material surroundings. And still others upon the ideas and value systems engaged by humans in their interactions with the environment. One feature that characterizes many alleged contributions to environmental history is, however, a holistic approach. Since human history detached from the physical world (that includes the human body) is unthinkable, much environmental history seeks to be h*istoire totale*. A kind of writing and analyzing history that truly acknowledges the material embedding of human history and concentrates on interrelations and connectivity.

So, although national delimitation of environmental history does in general make little sense, this brief introduction to the environmental history of modern Denmark will endeavor to view the country's geographical and biological foundations, its production and governance systems, and their underlying ideas and ideals as a whole.

From a somewhat condensed and superficial perspective, all western history could be described as a development through four major phases: prehistory before the Neolithic Revolution, pre-modern and early modern rural society, industrial modernity, and the present - whether we describe it as high modernity, reflective modernity, or post-modernity. The major transition periods being c. 6,000 BP, c. AD 1870, and c. AD 1980. This will be the (admitted: quite crude) chronology that the present text will in general relate to, although it focuses on the two latest centuries.

Landscape

In spite of its modest area (43,000 km2), the landscape of Denmark is characterized by one profound geographical variation. An uneven distribution of the ice sheet during the later part of the Weichselian Glaciation (c. 117,000-11,500 yrs BP) produced soil differences that fundamentally have determined

the plant cover and productive potentials during most of the past. The southwesterly part of the Jutland peninsula is characterized by outwash plains consisting of sandy soils that are nutrient-poor, and during most of the history generated extensive agricultural systems (animal husbandry, grazing) and a sparse population. Moraine clay, conversely, dominates most other parts of the country and resulted in more intensive mixed-farming and a higher population density. Today, these basic landscape differences have, to some extent, been concealed by two centuries of land improvement programs. Jutland, however, remains the national center of animal production rather than cultivation of plants.

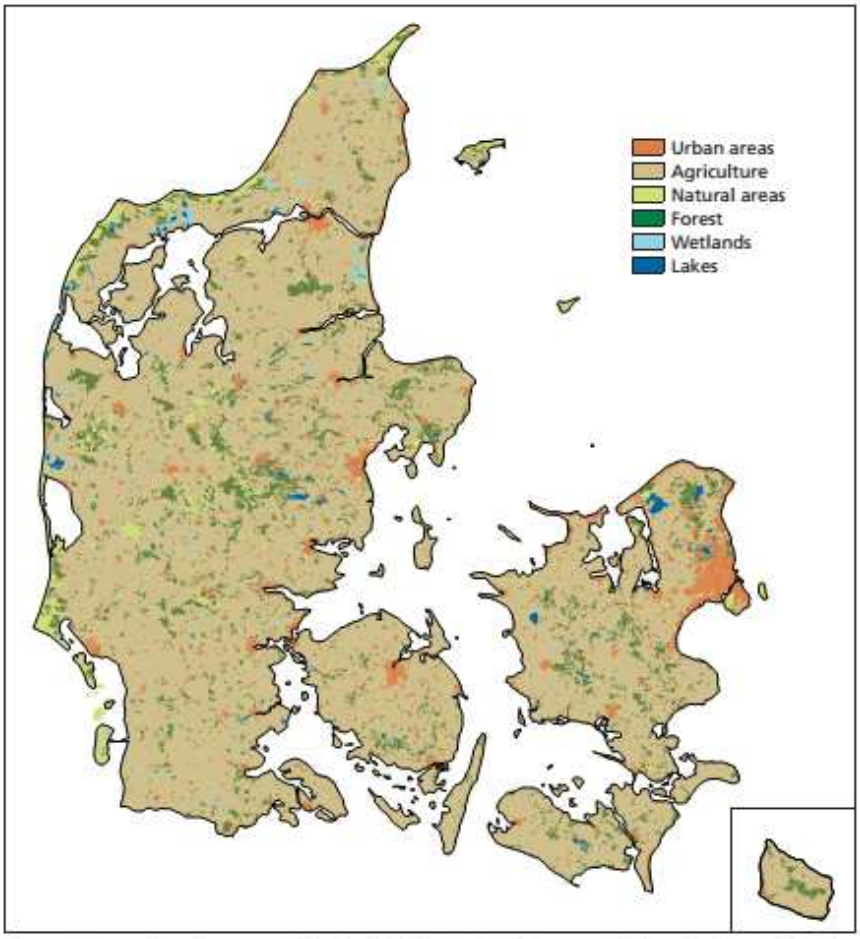
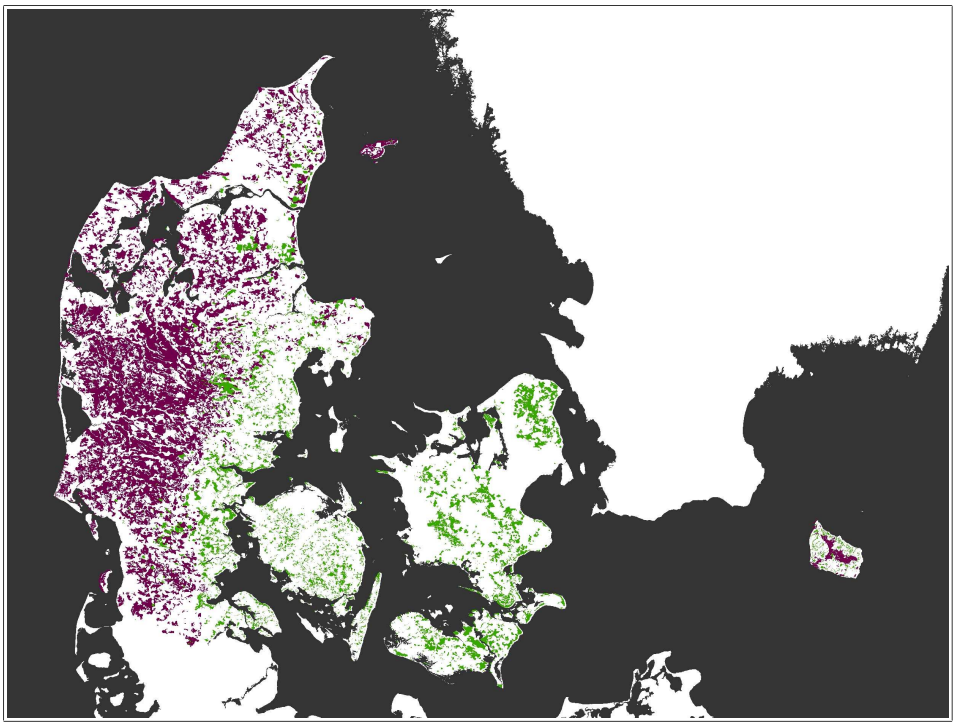


Figure 2.3 Land use in Denmark is classified in 6 main classes. Agriculture is the main land use all over the country.

Today's land use patterns in Denmark. About two thirds of the total acreage is arable, forests and other natural areas (bogs, meadows etc.) cover about 20%, and artificial surfaces (towns, roads etc.) about 10 %. Source: Running Waters

The extent of the country (the land-sea relation) has been anything but stable since the latest Ice Age. First, the melting ice uncovered a soil surface almost totally connected with the European mainland. As meltwater induced a significant sea-level rise of 30 meters in just about 900 years (c. 8,000 yrs BP), the area was fragmented into even more islands than today. Since then, due to the plasticity of the soil, especially Northern Jutland has experienced a gradual uplift (max. 13 meters) that has turned former seabed into coastal plains. Further, erosion and deposition of materials by water and wind contributes to an ongoing displacement of the border between land and sea.



The distribution c. 1780 of heather (purple) and wood (green).Data source: http://hiskis2.dk.

Even in a long-term perspective, however, present day Denmark is not only the result of such natural developments. Major anthropogenic changes have also taken place. Until some time during the 18th or 19th century, landscape variation and biodiversity are believed to have increased due to the dynamism imposed by land use. However, since the breakthrough of agricultural modernization (in the 19th century) and (in the 20th) industrialization, Danish landscapes have in general experienced a marked decline in biological diversity and natural values. Many species have become extinct, nutri-

ent-poor plant communities have decreased, and the formerly numerous wetlands such as bogs and meadows have virtually disappeared.

The most radical man-made landscape change was, however, clearly the conversion of the extensive moorland areas of Central and Western Jutland to coniferous plantations and arable during the nineteenth and early twentieth centuries. This was a development that not only almost exterminated many moorland species but also remarkably increased the woodland acreage of Denmark (by relatively relocating it in a westerly direction).

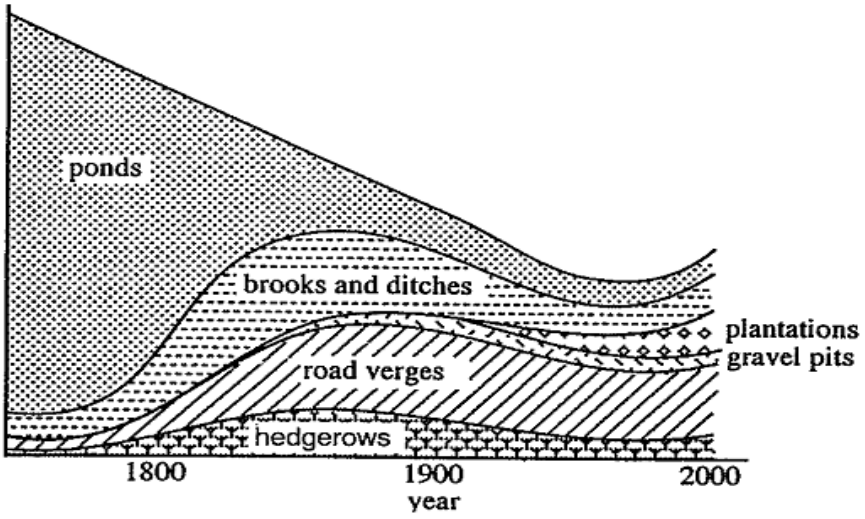
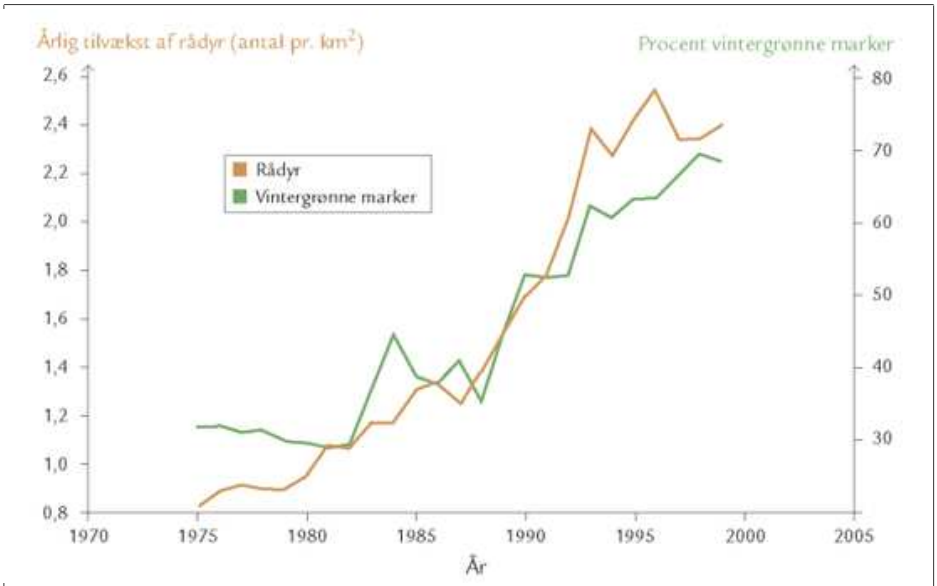


Figure 5.3 A rough outline of the long-term development trend of Danish small biotopes

Source: Rural land use and landscape dynamics as far as small biotopes are concerned. Source: R. Krsnert (ed.): Land use changes and their environmental impact in rural areas in Europe, 1995

Only within recent decades, major attempts to protect and restore such semi-natural areas have been implemented. Meanwhile, significant transformations in the wild life population are clearly man-made, yet unintended. For example, the introduction in the 1980s of winter green fields in an attempt to reduce leakage of nitrogen to the aquatic environment has multiplied the number of roe deer and, so, widely disseminated the Castor bean tick (*Ixodes ricinus*). It is a dreaded vector of a number of infectious diseases and is today considered to be “Denmark's most dangerous animal”.



Correlation between the annual increase in the population of roe deer (no per square kilometre, brown) and the relative extent of winter green fields (per cent, green) 1975-2000. Source: http://www.denstoredanske.dk/

Transformations in the biosphere, however, have not only consisted of reductions and extinctions. A range of new species have immigrated or been introduced to Denmark, and not all of them are equally welcome. So-called invasive species with a great ability to outdo indigenous organisms increasingly strain attempts to protect domestic species and gene pools. Among the most widespread invaders, one could mention such animals as Raccoon dog (*Nyctereutes procyonoides*) and Spanish Slug (*Arion* sp.), and such plants as Giant Hogweed (*Heracleum mantegazzianum*) and Japanese Rose (*Rosa rugosa*). Even some apparently unimpressive invaders can have a huge effect upon the landscape plant cover. Recently, the dissemination of the fungus *Hymenoschyphus pseudoalbidus* has caused extensive Ash Dieback in large parts of Europe.

In spite of frequently complex interrelations between land use, landscape change, and wild plants and animals, however, the general trend is undeniably one of declining biodiversity. A number of species have become extinct, and the prevalence of others has decreased significantly. Some decline is caused by pollution or eutrophication but for a number of animal species, human exploitation or eradication of habitats has clearly contributed. The population of hares, for instance, has declined markedly due to increased aver-

age field sizes (promoted by wider field tools) and a corresponding decline in hedges and other small biotopes.

Total annual bag of hares, 1940-2010. Source: Danmarks Natur 2010

People

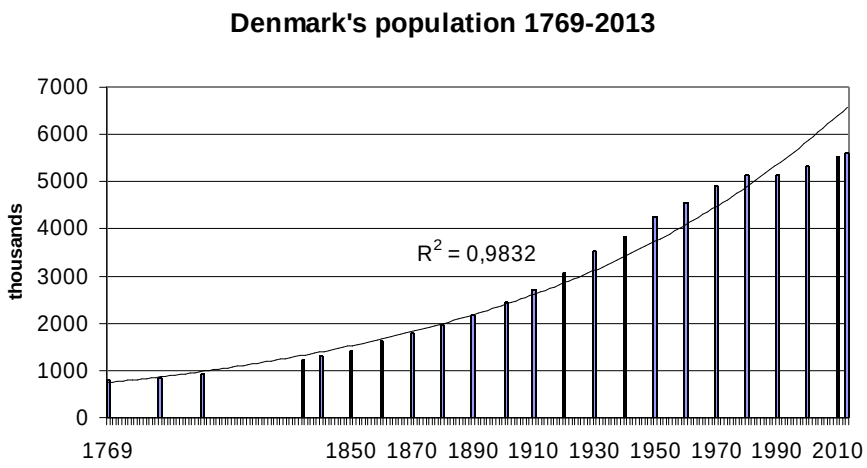
Today, the Danish population consists of 5.6 millions and apart from a few years in the 1980s the level has been increasing since the first census was made in 1769. During the last decade, the annual rate of increase has been approximately 0.4 % that represent a noticeable slowdown of population growth.

In 1769, the Danish Kingdom (omitting Southern Jutland then belonging to the Duchy of Schleswig) consisted of 800,000 persons. It passed one million some time between 1801 and 1834, two millions c. 56 years later (1890), three millions 29 years later (1919), four millions 26 years later (1945), and finally five millions 28 years later again (1973). Until a generation ago, the development was clearly exponential but the growth rate has been declining for quite some time now.

The demographic stagnation is typical for most developed (and hence rich) countries. Affluence appears to reduce reproduction. And on a global scale, the Danish society is extremely rich. In a number of different international rankings of GDP per capita the country ends up among the top ten. But the growth in national GDP is clearly waning. Some fifty years ago, the annual increase was about 4.5 %, today it has changed to a decrease of 0.3 % (2006-10). The riches are, however, distributed quite evenly largely thanks to a progressive tax system that enables a high level of social security (the Welfare State). In 2008, the so-called *Gini Coefficient* of Denmark that expresses the

rate of equity (if 0, incomes are distributed totally equally) was 0.22. In USA, it was 0.47.

For most of our known history, family and kin formed the basic structures of social life. Until the nineteenth century, infant mortality was high and so was the number of child births. Life expectancy for new-born babies was short; in 1850, about 45 years for women.



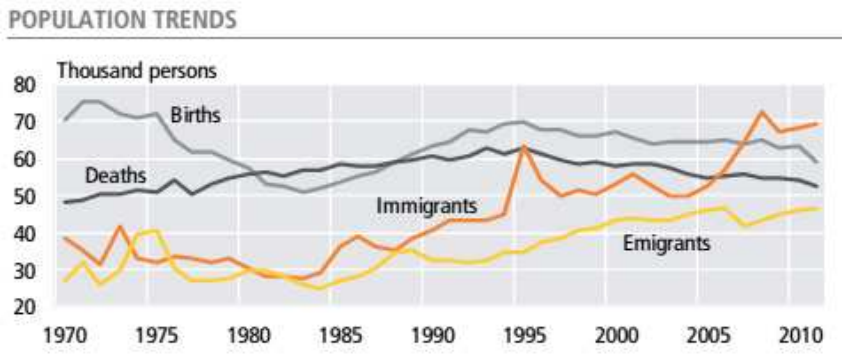
Until c. 1980 a rather steady population growth rate was maintained but since then the development has slowed down. Source: Official demographical statistics from Statistics Denmark.

But today, the Danish population has grown old. In 2013, the life expectancy by birth is 82 years for women and 78 for men. And what is more, the social structures of every-day lives are being hastily transformed. The annual number of divorces is more than half of the number of marriages. And there are now equally as any households consisting of a single (parent) as there are traditional nuclear families.

Further, since the 1970's immigration from primarily Turkey, Pakistan, and the Middle East has been a new – and to some disturbing - element in Danish society. From having for centuries been a small (almost tribal) ethnic group, the Danish population has been gradually globalized, and cultural integration is suddenly a major political issue.

Several factors contribute to the general improvement of the Danes' biological living conditions. Firstly, the state of nutrition has in general improved

significantly during the last 200 years, and today obesity is a far more prevalent problem than malnutrition. Secondly, development of Penicillin and other antibiotics has heavily reduced the number of infectious diseases that previously caused especially many infant deaths. So, effective manipulation of the microscopic environment has had a deep societal impact.



Danish population trends during the latest four decades when globalization in the form of immigration began to have an impact. Source:Denmark in Figures 2013.

Settlements

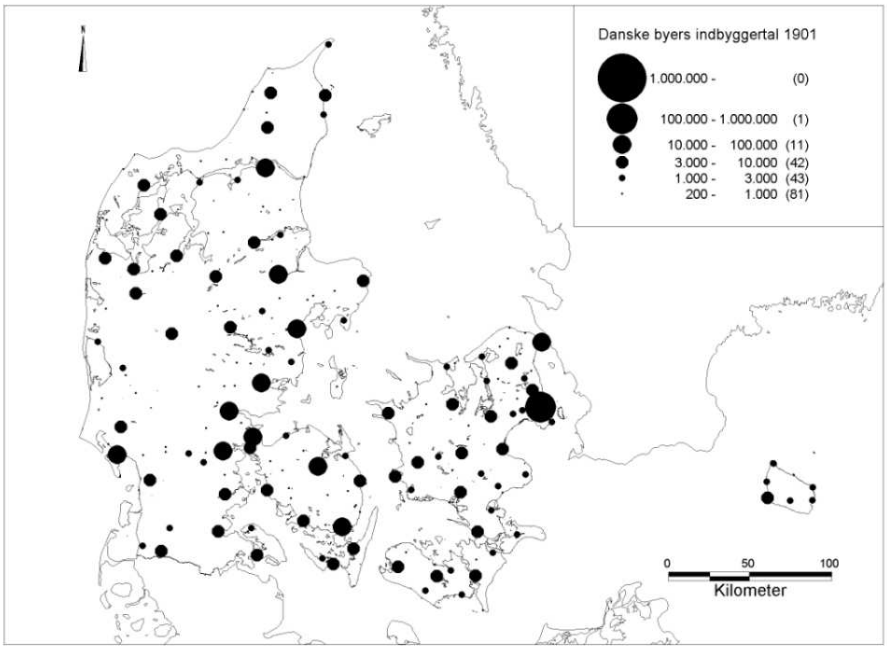
The transformations of the traditional family reflect a transition from the dominance of rural ways of life towards urbanity. The general settlement pattern of early modern Denmark was a rural one characterized by villages and hamlets on the intensively tilled moraine soils in the east, whereas the villages located on the out-wash plains in the west were supplemented by scattered single farms. So, until the nineteenth century, the large majority of the population lived in either provincial towns or in rural villages, and at least 4/5 were directly employed in agriculture.

During that century, however, the overall settlement pattern changed fundamentally. In the last decades of the 1700s, the ancient open field system had been abolished through major land reforms resulting in the gathering of all lands belonging to each farm in just one lot. And subsequently, most farms were removed from their old location in the village to these new lots (many of which were later parceled out resulting in still more scattered buildings). So, the rural settlement was in general dispersed, and the landscape became more densely populated than previously.

Parallel to this development in the countryside, the population of most provincial towns and cities increased – especially during the industrialization

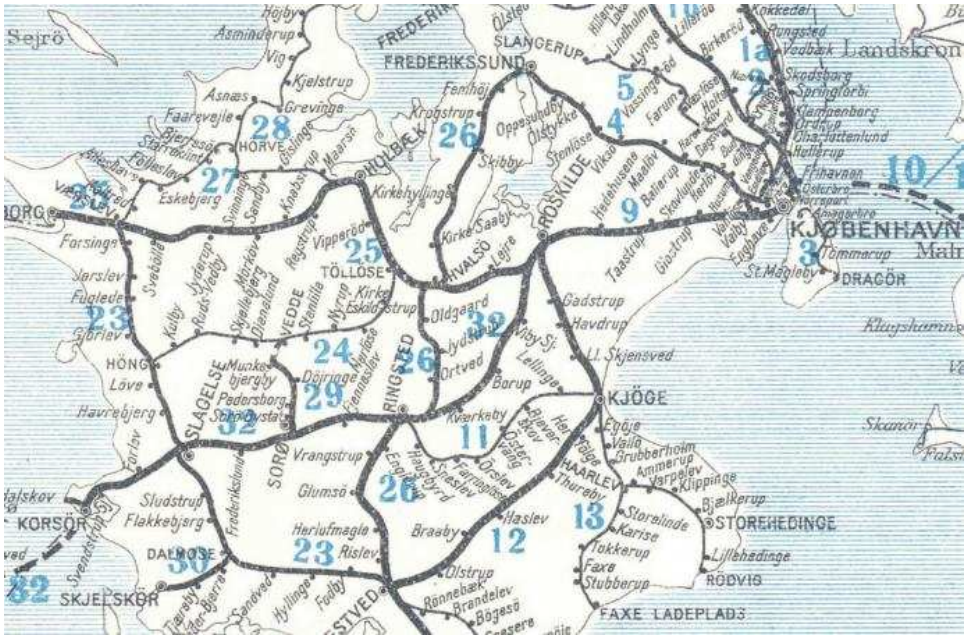
period from the 1870s. From 1840 to 1901, Copenhagen, where the most notable industrialization took place, grew from 121,000 to 454,000 inhabitants (275 %).

In average, residential blocks became taller and flats got smaller and this increasing urban population density had fatal consequences during, for instance, a major outbreak of Cholera in Copenhagen 1853. Following the epidemic, most market towns demolished their medieval defense structures in order to expand on the arable fields traditionally belonging to all towns. Against modern artillery, moats and walls were no good after all.



Danish towns 1901 with indication of population size. Source: http://www.byhistorie.dk

Provincial towns with a medieval heritage attracted the quite significant surplus population from the countryside that could find neither occupation nor dwellings as farm laborers. But they were not alone in attracting this population surplus. Simultaneous with the dissolution of villages and the consolidation of towns, a new kind of small market towns appeared. They specialized in functions within public service or private business, and they normally emerged in close connection with a new net of railway lines throughout the country.



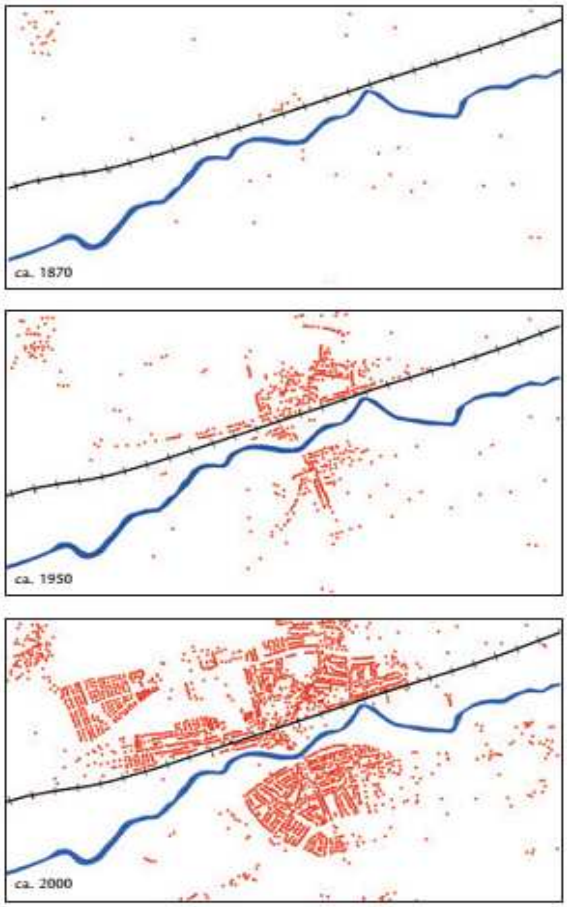
Section of map of the tightly woven railway network on Zealand c. 1930 (when its density was at the highest). No location had more than c. 15 kilometers to the nearest railway station. Source: www.kulturarv.dk.

After the establishment of the first railway connection between Copenhagen and Roskilde in 1847 (30 km), the network peaked with roughly 5000 kilometers of rails and a great number of new, small towns in the 1930s. In some cases, the route intersected existing villages. Elsewhere, such settlements were virtually divided between an old church center and a new "railway town". And occasionally altogether new towns appeared.

During the twentieth century, most towns (big or small) were divided into sectors according to different functions: Industry, public administration, trade, housing, etc. Suburbs originally consisting of detached houses for the upper and middle classes appeared, but during the economic boom of the 1960's the acreage of all towns increased significantly due to a large-scale expansion of suburbia. A great number of the small market towns of the early railway epoch have today lost almost all other functions than housing, and they appear as small islands of suburbia in the ocean of rural landscapes as they have also received new inhabitants who have left the inner cities in order to live in 'more natural' surrounding.

Concurrent with this renewed dissemination of urban settlements, increasing industrial demands for accessibility and space combined with popular

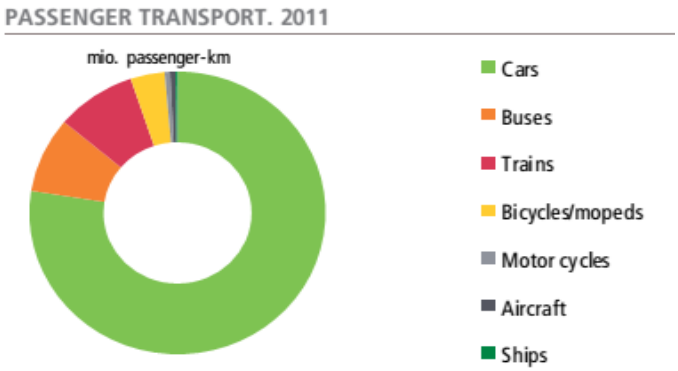
discontent with noise and other kinds of pollution caused most industrial plants to leave their original downtown locations for specifically designated industrial districts in other parts of the city periphery. And with today's out-sourcing of industrial work places to distant low-wage-countries, secondary sector plants have become still more scattered.



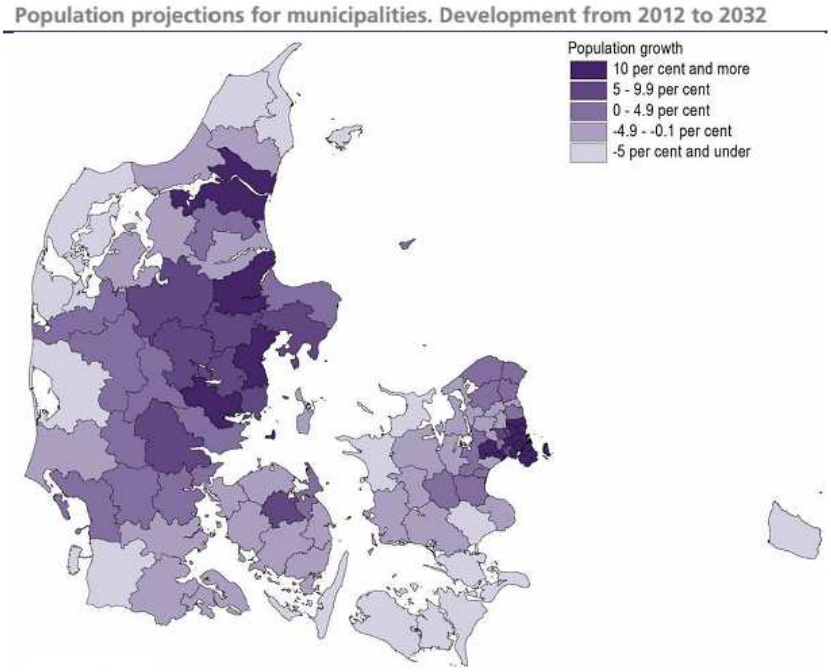
Settlement development 1870-2000 in the area that after building of a road bridge and the coming of the railway was to become the new small town Bjerringbro on the banks of the river Gudenåen in Central Jutland. In the upper left corner is the old rural village Bjerring. Each red dot symbolizes a house. Source: BF

In all, transformations in the settlement patterns during the latest two hundred years have greatly increased the needs of a well-functioning transport infrastructure. Since the 1930s, the railway has gradually receded for the benefit of individual car traffic. Today (2012), Denmark has 2,650 kilometers railway and 73,929 roads and during the latest twenty years the number of

private cars has in average increased by 1.7 % per annum (to 2.2 mill. passenger cars in 2013). As a consequence, private transportation represents a considerable part of both energy consumption and air pollution.



Distribution of domestic passenger transport on types of vehicles 2011. Source:Denmark in Figures 2013.



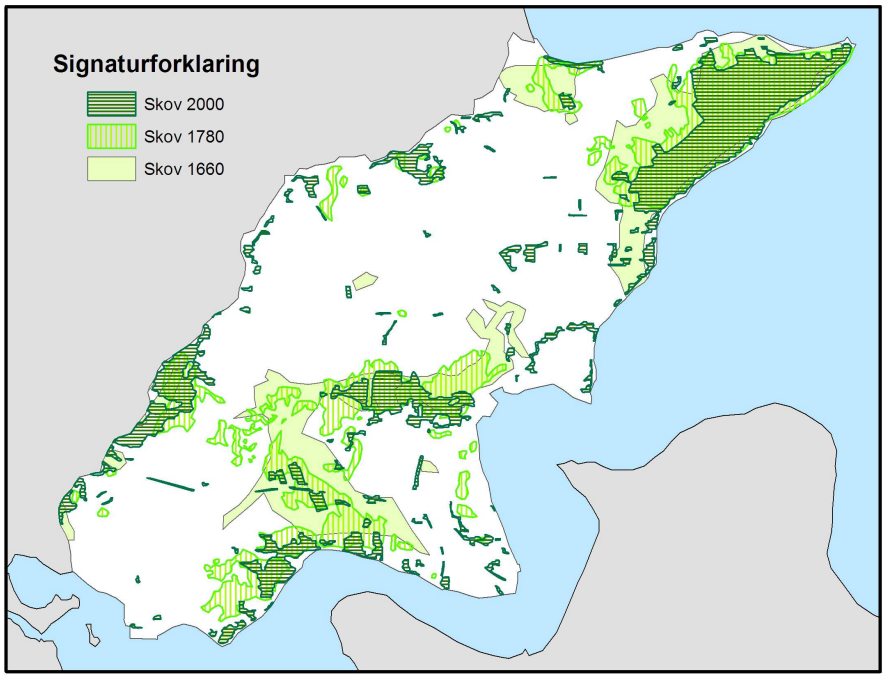
Population development projection. Source: Statistical Yearbook 2013.

As a recent development, traces of re-urbanization are visible at least in the larger urban areas of greater Copenhagen and East Jutland. In capital's search for profitable investments until the financial bubble finally bursted in 2007,

dock areas and abandoned industrial plants have been reshaped into post-productive, high-cost housing areas. Meanwhile, however, prosperous economic activity (and work places) has a tendency to be centralized in certain parts of the country leaving a periphery of abandoned farm buildings and partly depopulated market towns consisting mostly of senior citizens.

Natural resources

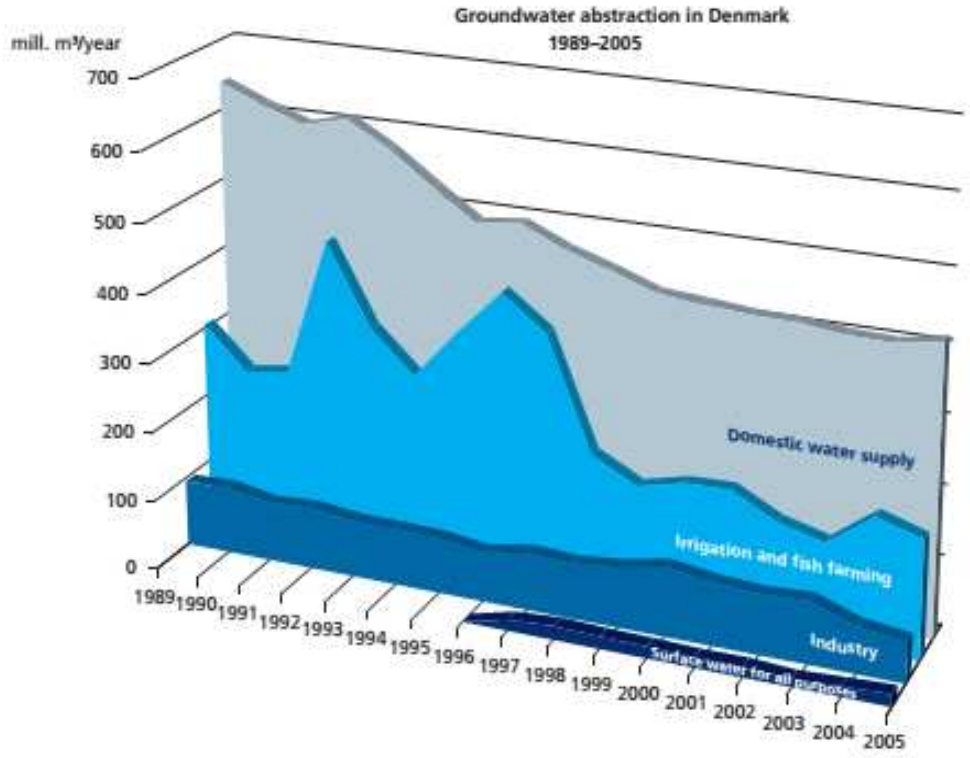
The ground, the plant communities covering it, and the animals feeding on them were together the natural resources on which traditional rural Denmark based its existence. And for as long as agriculture formed the predominant mode of subsistence, soil qualities defined the limiting and enabling scope of local economies. Still, some of these resources were gradually employed by other sectors whereby they achieved a certain importance for the modernization of society at large.



The fragmentation and reduction of woodland (= skov) in a part of Eastern Jutland since c. 1650. Source: BF.

As in most of Europe, woods and their trees formed one of the first natural resources to become scarce and – hence – to be subjected to state regulation. Attempts were made already during the Middle Ages to ensure future supplies of both timber and fuel wood, but the method selected proved worth than nothing. In a feudal society where royal, noble or clerical landlords were

regarded as the real proprietors of all natural resources whereas ordinary peasants had normally only use-rights to their own farms, a similar stratified ownership regarding the forest seemed natural. So, it was decided that landlords would have exclusive rights to all tall trees while the peasants could control brushwood and copses. The long-term result of the solution was a general reduction in tree sizes.



The size and composition of Danish groundwater consumption since 1989. Source: Water supply in Denmark.

Further, wooded areas were normally used simultaneously for wood production and pasture, and browsing animals severely damaged the regeneration of the stands as young trees were trampled down, uprooted, and devoured. So, all in all, the early modern period experienced a notable deforestation.

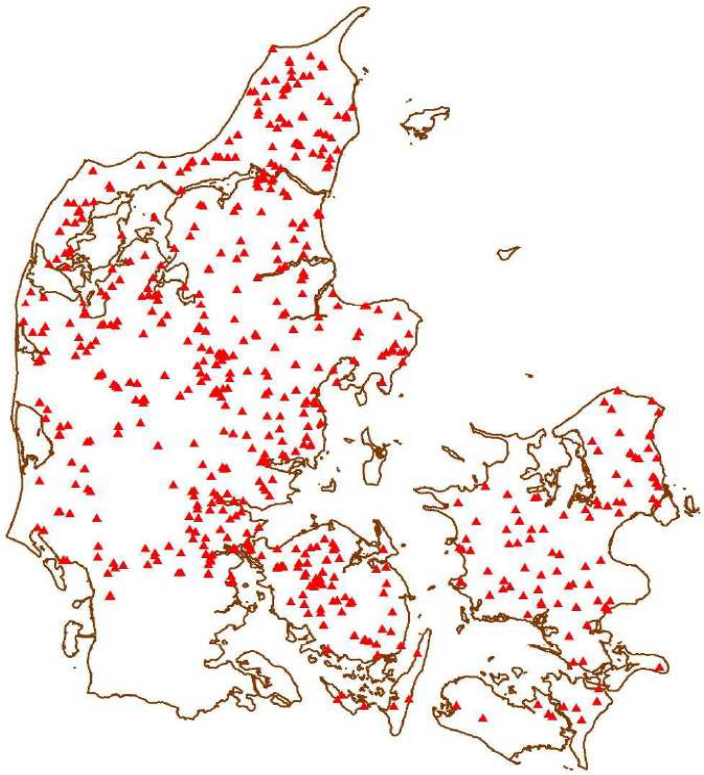
This development was, however, stopped as part of the late eighteenth-century land reforms. In 1805, it was decided that common ownership to woods should cease, that areas with remaining high forest should be managed sustainably in order always to remain forested, and that browsing domestic an-

imals should be excluded from these future forest areas. After this, old woodland fringes with only shrub or no trees at all were subsequently turned into arable lands. But the legally protected high forests remained, and today they display a conspicuously insular appearance in the rural landscape surrounded by earth stone walls as protection against browsers as they all are.

Another domestic raw material heavily exploited during modern history is freshwater. In traditional rural society, water was extracted from lake or stream surfaces, or by wells dug deep enough as to reach the groundwater level. In a modern, industrialized society, however, this extraction is clearly not sufficient, and since the late nineteenth century only mechanically purified groundwater has been pumped out into networks of water mains that distribute the essential raw material to private homes, manufacturing and agriculture.

But even though the earth system water cycle leads discharge water back to the aquatic environment and, so, back to the groundwater with an annual consumption of 650-700 million m3 this recirculation is too slow to keep up with the extraction. Therefore, and as still more water wells get polluted by farming chemicals, it is considered to segregate the future supply of drinking water from other (less clean) water distribution.

Continuously exploited gravel pit in Zealand. Source: BF.



The location of Danish brickworks in the first period of urbanisation c. 1880 (the duchy Schleswig in southern Jutland, then Prussian, not included). Due to the dispersed localization of both heavy raw materials and consumers, tile production represented a remarkably rural kind of industrialization. Source: BF.

The third domestic natural resource with a long-term application in both traditional rural society and today's (post)modern is soils. The building of brick houses and all kinds of cement construction requires sand, chalk and gravel, and large areas of farm land have been improved by use of marl (calcareous soil) - all non-renewable natural resources to be found in the Danish underground.

In the rural society, exploitation of specific soil types was purely local and so were its impacts on the landscape. But as brick-structures during the nineteenth century replaced timber frames, and as urbanization and population growth caused the general demand for building materials virtually to explode, pits of various kinds became common all over the country. When their use was industrialized in the following century, state regulation selected spe-

cific zones for this purpose. And today most extraction of raw materials takes place in the sea bed.

Until quite recently, wood, water, and soil were the only significant natural resources to be extracted from the Danish landscape – apart from the biological outputs of agricultural crops and livestock. Firstly, however, with the use of sub-marine compounds during the 20th century, the resource inventory was significantly enhanced. And secondly, it is not preordained (and a-historical) what exactly we consider as 'resources'. So, in recent years, numerous non-material modes of land use are being considered as ecosystems-services re-interpreting, for instance, biodiversity, groundwater protection and carbon-binding as new kinds of natural resources that become subject to political interest and discord.

Energy

Energy is an indispensable physical condition for getting something done, and the most basic kind of energy used by humans is the same kind that all animals use: Muscle power. For millenniums, this kind of simple biological energy was totally predominant, and by the introduction and dissemination of agriculture human and animal power were merged in the same productive efforts.

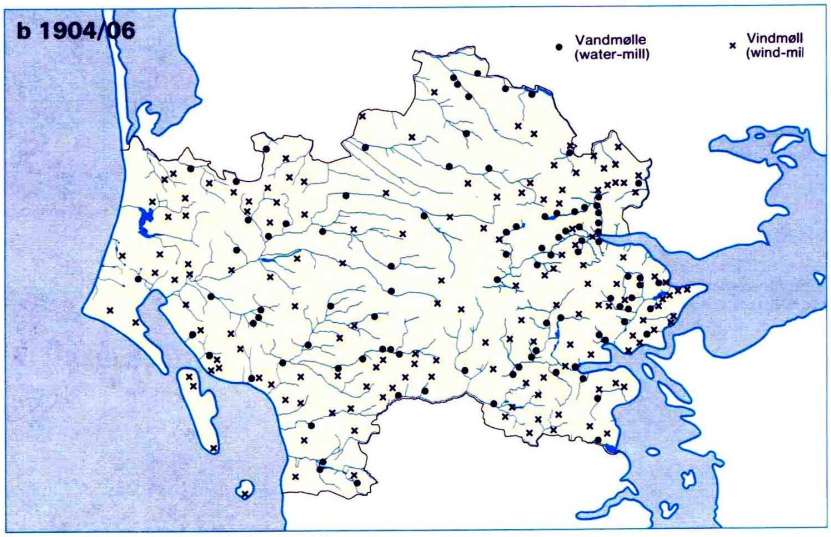
Today, non-material jobs dominate and the use of muscle power is being still more confined to leisurely fitness practices that aim at bodily health rather than at actual production. For with the transition from first and second sector towards third sector jobs, the Danish population is taking part in the worldwide epidemics of obesity.

The first form of non-biological energy accessible to humans was heat energy in the form of open fire. And from prehistory and until the 18th century, the all-dominant types of fuel were wood, peat and (for specific industrial purposes) charcoal. As biological carriers of energy (bound in carbon compounds), these sources were, in principle, all renewable but as demands gradually exceeded the supplies, deforestation and exhaustion of the bogs' peat layers followed.

One prominent type of kinetic energy was, however, introduced already during the Middle Ages: The water mill. At first, it was closely connected with arable farming and the transformation of grain into flour. But gradually, some water mills became centers of early industrialization. So, kinetic power

transmitted from water wheels was eventually used in both textile and iron industries.

During the early 19th century, however, water mills were gradually replaced by wind mills with steel constructions. Agriculture demanded (and got) legislation effectively promoting general drainage of arable lands, and this affected the possibilities for the water mills negatively. And since wind mills could be located almost anywhere, they soon turned out to have a competitive advantage. So, until the final takeover by electrical mills around 1960 windmills could be found in or near almost all rural towns.



Locations of water and wind mills c. 1905 in South Jutland. At this time, the latter were slowly becoming dominant. Source: Historisk Atlas Danmark

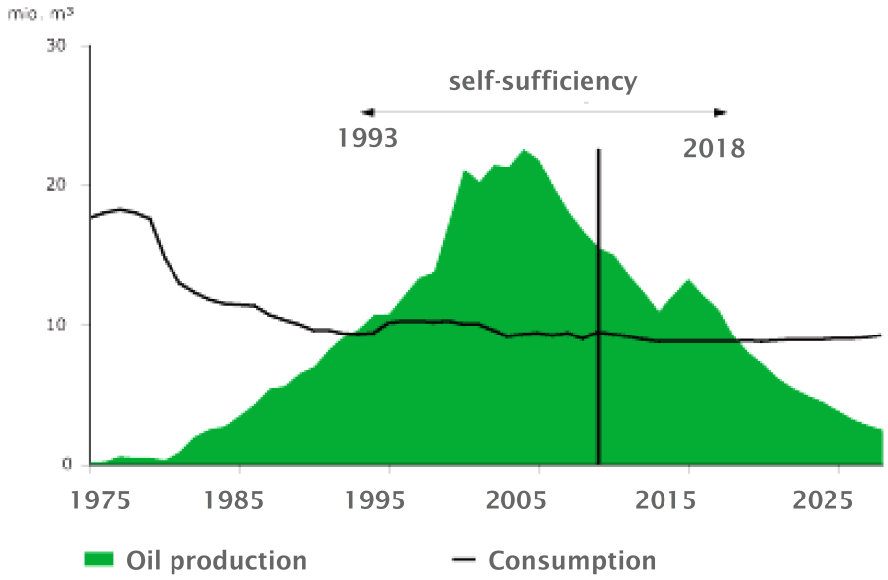
Since Thomas Edison's invention of a system for the distribution of electricity in 1880, an increasing quantity of energy all over the world is being transformed into easily distributable electricity. In Denmark, Copenhagen and some larger provincial towns were the first to introduce communal power supplies.

During the period 1905-20, the number of electricity plants increased from c. 40 to 500, and the distribution network branched out eventually to cover the entire country. The great majority of plants were fueled by coal, but during World War 1, quite a number of more or less derelict water mills were temporarily used to produce electricity as the overseas coal supplies were scarce. Since then, the total consumption of electricity has increased dramatically,

but since c. 1980, the share delivered from large, newly built windmills on land and at sea has increased from nothing to presently about 1/3 of the total production. Meanwhile, Denmark remains one of the world's relatively largest consumers of coal.

During the 20th century, the electricity grid together with railways, roads, sewers, water supplies, district heating, telephones, fiber-optic networks for digital data traffic, etc. turned the Danish landscape into a cluster of refined networks distributing people, materials, energy and information. And the network nodes are constituted by industrial plants, offices, and homes.

In 1962, the private enterprise *A. P. Møller* was given exclusive rights to search for and produce oil and natural gas in Denmark, and ten years later extraction began in the Danish part of the North Sea seabed. During the 1980's extraction of both oil and gas increased considerably and since 1993 the country has been self-sufficient with oil. According to contemporary projections, however, self-sufficiency will only last a few more years, and Denmark will again become a net energy importer just as most of Europe.



Danish oil production from the North Sea until now and with forecast for the future. Source: Danmarks olie- og gasproduktion 07, Energistyrelsen2008

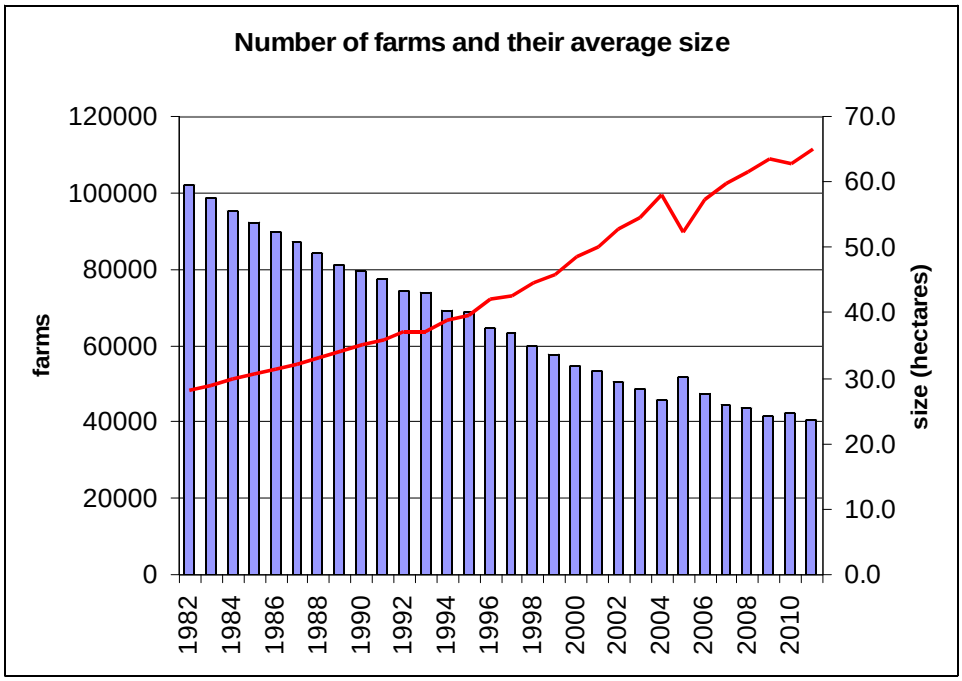
So, alternative sources of energy are now being chased – among them domestic shale gas. But in view of man-induced climate change, it is far from evident that our future energy supplies should be based on fossil fuels, and a gradual transition to alternatives has already begun. In 2010, 22.2 % of the

total, national energy consumption originated from renewable sources (wind, wood chips, and solar energy) – the average for the EU being 12.5 %.

Still, Danes have an additional unreported energy consumption even when they are not abroad. The fabrication of goods that are imported to the country is, evidently, based upon energy consumption in the place of origin. So, the total amount of energy needed to uphold Danish society at its present consumption level is far greater than the figures appearing in official statistics convey.

Production

Production is a key activity in the relationship between humans and their physical environment, since it is the production process that most manifestly interconnects the two: Natural compounds are by the use of energy as resources put into a technological production process, were by they are transformed into an article for use or sale, whereas surplus materials are discharged to various landscapes sinks as pollution.



Recent developments in the structure of Danish agriculture. Source: Statistics Denmark.

For more than 6000 years, most of the history of Denmark has been one of agriculture. Around 1840 about half of the population were still directly en-

gaged in arable farming and husbandry. But this primary sector of production was to experience a steady decline during the following decades. A hundred years later more people worked in the secondary sector of industry and crafts (about 1/3 of the entire population against c. ¼ in agriculture), and today both the primary and secondary sectors have been overtaken by commercial and administrative jobs in the tertiary sector.

Still, the relative part of Denmark used as arable has only declined a little. So, from a landscape perspective, the depopulation of the countryside has expressed itself as considerably fewer and bigger farms.

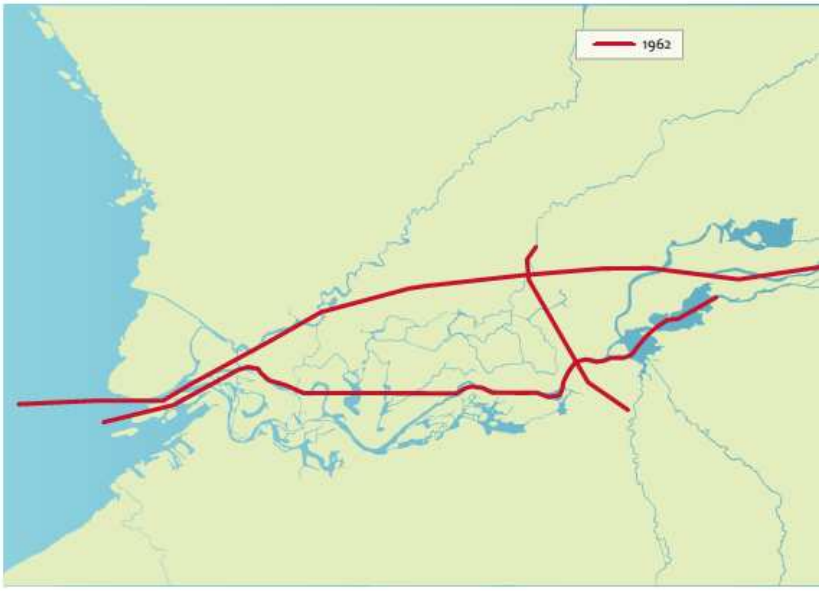
In an industrial society, the productive apparatus (machines, etc.) is all man-made. But in the primary sector that is based upon either extraction of naturally-occurring substances or upon the productive capacities of plants and animals, improving that apparatus is in itself a direct manipulation of the environment. So during the latest 200 years of modernization in agriculture, the Danish landscape has been greatly transformed in order to optimize production.

During the nineteenth and twentieth centuries, rural landscapes were transformed in a number of ways in order to increase agricultural outputs by optimizing the micro climate and the soil's physico-chemical properties. Shelter belts were planted in great number in order to reduce the hazards of wind erosion – especially on the sandy soils, in Jutland.

The total number of shelter belt trees planted (in millions) with government subsidies 1866-2000. Source: BF.

Clayey fields all over the country were provided with finely branched networks of drainpipes so that about 50 % of the arable is today artificially

drained. And the majority of natural rivers and streams were straightened out or even piped in order to improve their drainage. So, present landscapes are relatively desiccated with the result that a number of plant and animal species dependent bogs, fens and other waterlogged landscapes are threatened by extinction.



The regulation of the delta of Skjern River in 1962 was the last and largest of all Danish river regulation projects. The red lines indicate the localization of the optimized water course. Source: BF.

Apart from improving the productive potentials of the arable, its size was also increased. Not only were bogs and moorland drained and cleared. Large-scale land reclamation from the sea by use of dikes and pumps transformed a number of inlets to arable. But even though really extensive land reclamation plans comparable to the Netherlands were fostered during the 1960s, most agricultural land improvement activities came to a halt during the concurrently growing environmental awareness.

The industrialization process in Denmark was comparatively late, and its impact on the environment was comprehensive but not as place-specific as agriculture's land improvements. However, on a small scale the industrial factories themselves did, in fact, form a new kind of physical environment that was very different from the workplaces known before. And that environment was indeed a challenge to the humans working there.

The island Amager south of Copenhagen was significantly enlarged by land reclamation during World War II; not as much for the sake of agriculture but rather to reduce unemployment in the capital. Map of the original Amager c. 1720 is here placed on top of a recent map. The location of UCPH's Southern Campus is marked with a red cross. Source:The Royal Library.

Just as anytime industrialized production is introduced, humans were in the beginning a comparatively cheap and dispensable factor of production whereas the machinery represented a significant investment of capital. So, the workers' health and safety remained low priority for some generations, and the bodies and lives of thousands were marked by the bad working conditions. Noise, air pollution, heavy lifts, and monotonous repetitive movements.

No wonder that the working environment was among the first topics to be addressed by the environmental movements of the 1960s and '70s. As a result of their work, the area became strictly regulated, and today de-industrialization in the West has moved most hazardous jobs and polluting processes to the Third World.

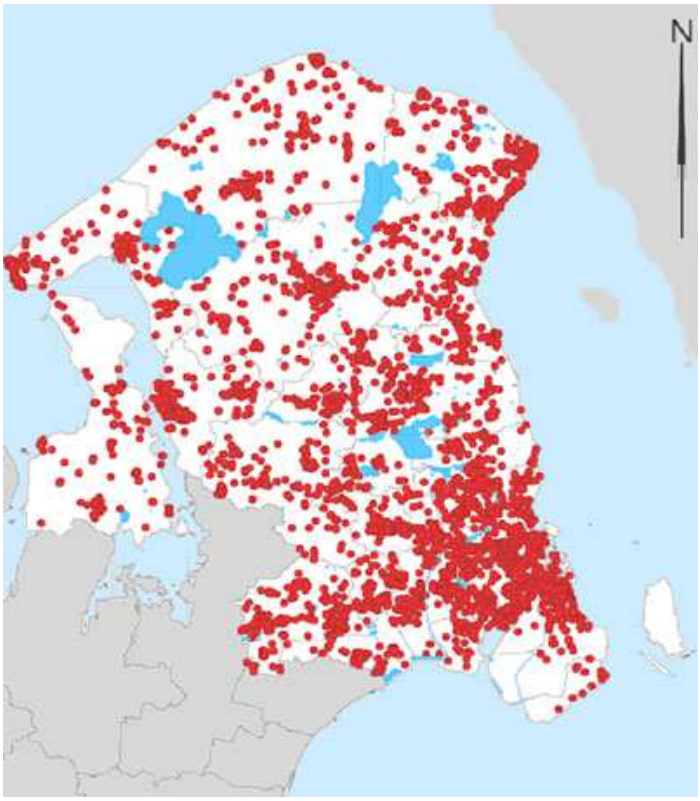
Pollution

In 1852, the British lord Palmerston defined dirt as '*a thing in a wrong place*'. And in this very broad definition, pollution – i. e. the production of dirt - has always existed. Discharge of midden water from arable farms or toxic tannins from tanneries have created local problems for centuries. And since population density was of key importance for the impact of productive activities on the environment, pollution first evolved into a matter for public discourse in towns.

In market towns, removal of night soil from a dense population had always been a challenge, and in general, they were hazardous places due to a ubiquitous infection risk. In the eighteenth century, water in the harbor of Copenhagen was e. g. so acidified from human waste that the ships' ropes c corroded. And from about the same time, a growing number of specialized productions locally constituted an environmental challenge. Firstly, of course, this was the case with numerous furnaces fired with peat, charcoal or imported pit coal.

In the beginning, such industrial pollution was mostly a menace to the workforce. But with enhanced industrial productivity followed increased outlets of polluting substances to the three natural sinks: the soil, the aquatic environment, and the atmosphere. So, with the same efficiency that industrialism produced commodities it affected the environment. And the twentieth-century Danish history of pollution resembles that of the rest of the western world: Increasing strains on the environment based upon a deep belief in the

resilience of natural systems gradually followed by sporadic concern that finally put pollution control on the political agenda.

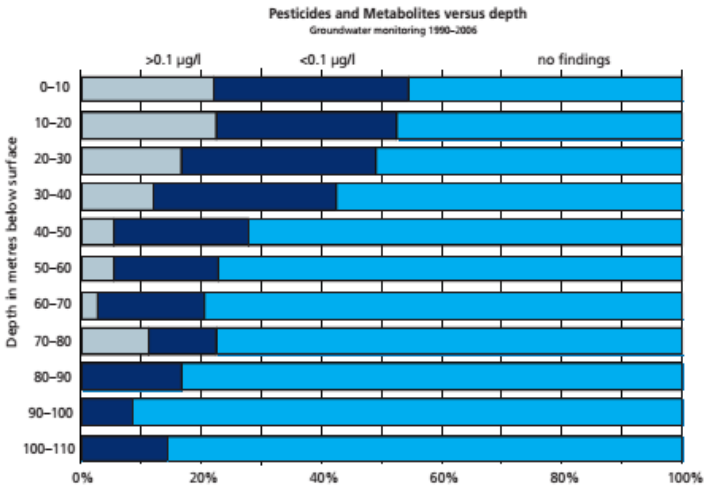


Known sites of polluted soils in Northern Zealand. Source: http://www.regionh.dk.

Industry, however, was not the only major polluter. When it comes to the most visible kind of pollution, the production of solid waste, ordinary household did - and do - contribute significantly. In 2008, the overall annual production of solid waste equaled 2.8 tons per inhabitant. Until the 1970s, most garbage was simply dumped in abandoned gravel pits, on land reclamation areas, or in other similar places. But today, the major part of this huge wage production is either recycled (69 %) or used for energy production as district heating and electricity (23 %).

It was only recognized late (in the 1980's) that agriculture could also act as polluter. The long-term use of pesticides and weed killers in agriculture clearly threatens the ground water reservoirs (and thereby the water supply) all over the world. In Denmark, still more ground water wells are being closed due to toxic pollutants since the period from application until they reach

the ground water level can be quite protracted. Yet, poisonous substances is not the only environmental threat from agriculture.

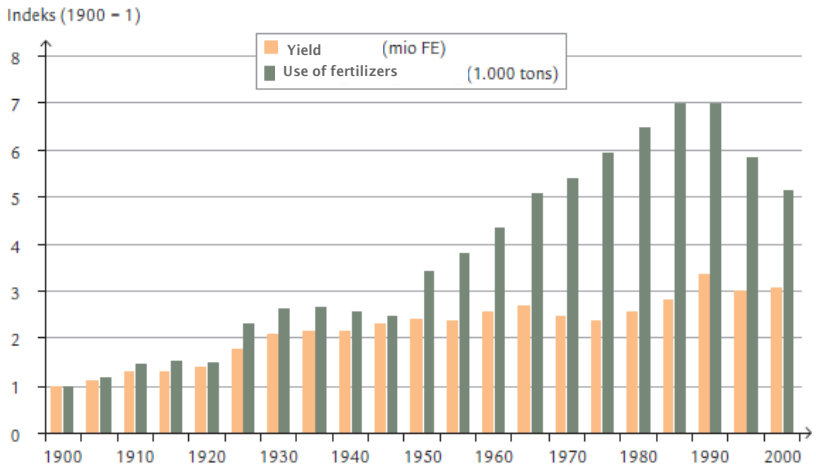


The relative number of water drillings affected by specific pollutants at different depths. Source: Water supply in Denmark.

Although outputs did not follow, the use of natural and synthetic fertilizers increased during most of the twentieth century, and the growing discrepancy between the input of nutrients and the crop output represented a major leak to both air and water.

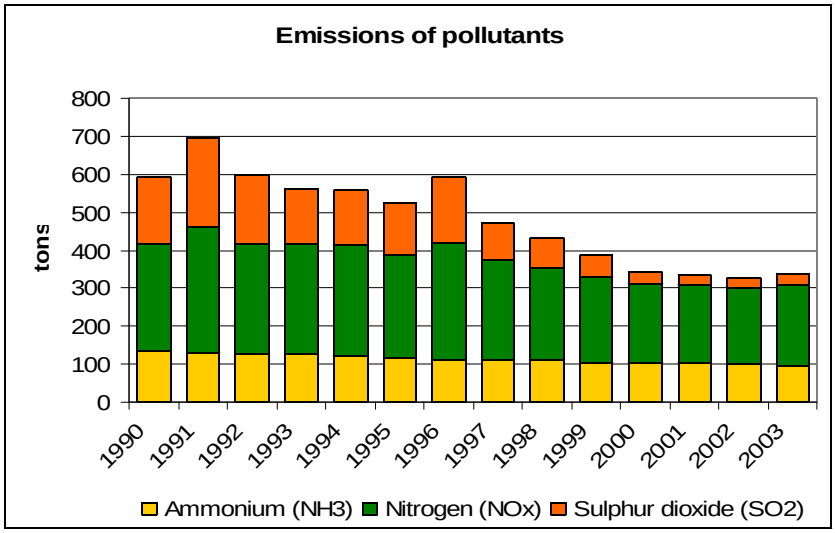
Deposition of airborne N greatly diminished the number of nutrient-poor plant communities whereby it contributed to the general degradation of biodiversity. And emission of Nitrogen and Phosphate to the aquatic environment caused recurrent incidents of hypoxia followed by mass deaths of fish and shellfish in the inner Danish waters during hot summer months.

Agriculture, however, was naturally not the only source of water pollution. Industry and households took their share, but the chemical imprint varied according to source and in many instances, the mixing ration posed the greatest problem. In the example just mentioned, it was the actually the combination of N from agriculture and P from industry and households that caused the bloom of algae, which deoxidized the water with devastating consequences.



Crop yields in Danish agriculture compared with its use of fertilizers. Source: BF.

Since the 1970s, however, most sewage from industry and households has been treated in municipal plants, so the general water quality has improved greatly. As a consequence, it is today possible to bathe even in the harbor of Copenhagen.



Changes in the composition of some notably polluting compounds. The reduction of Nitrogen-compound emissions has still not been very successful. Source: Statistics Denmark.

Air pollution was from the beginning closely related to both in- and outdoor industrial emissions of smoke and dust consisting of a variety of components. This source of pollution is today largely regulated, but other sources continue to make allergy, cancer, heart conditions and respiratory illnesses related to poor air quality a considerable problem. Transportation based on diesel driven vehicles such as trucks and motor ships is an extensive cross-frontier menace since diesel engines emit a number of harmful particles. And the same does cozy hearths fired with unclean or moist fuel wood. The use of fuel wood increased remarkably after the international oil crises of 1973-74 and 1978-80.

By the middle of the twentieth century, it became evident that humans were profoundly influencing the chemical composition of the atmosphere. Due to large-scale combustion of fossil fuels in industry, transportation and households, the content of carbon dioxide increased. A gas that is the normal outcome of ordinary life processes was suddenly to be considered as a pollutant: Too much of a thing in a wrong place. For in the atmosphere, CO_2 creates a shield that holds back heat and so influences the global climate.

As in the rest of the world, however, this was not realized as anything but a scientific matter of course until the late 20th century when environmental movements and politicians finally began to move. So, in 1997 some, but far from all, countries signed an agreement to reduce the emission of CO_2 and other so-called greenhouse gases. In accordance with this agreement, Denmark reduced its emissions with approximately 11 % in the period from 1990 (the Kyoto Protocol baseline) to 2010; but the target had been a 20 % reduction. And meanwhile, expressions of climate change became still more explicit: More frequent phenomena of unpredictable wild weather, meltdown of the polar ice caps, and a general rise in temperatures.

On a practical level, climate change is going to have a tremendous impact on large parts of Danish society. Harbor facilities, sewage systems, and a great many buildings are being remodeled in order to be able to resist both elevated sea levels and increased precipitation. And in agriculture and forestry, new plant species and genetic varieties are being introduced that are suited to adapt to both rising CO_2-levels in the atmosphere and general warming.

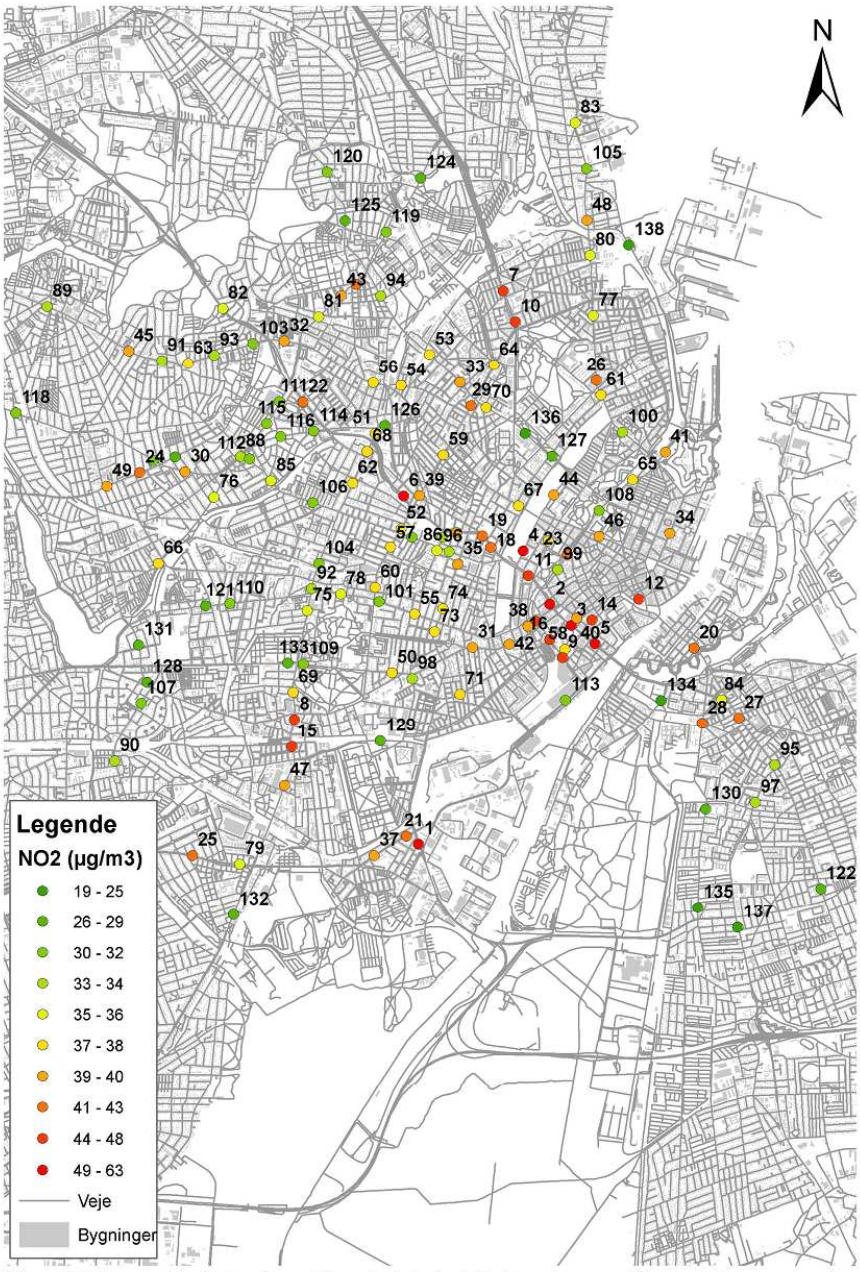
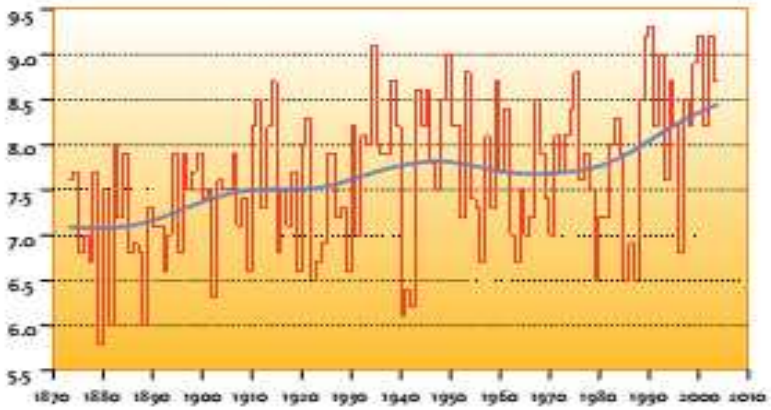


Figure 3.4 Map showing the locations of the selected streets in Copenhagen and the annual mean concentrations of NO_2 for 2010. The contribution from traffic in the street canyons is based on the street canyon model OSPM. The urban background is obtained from calculations with the urban background model UBM with input from the regional scale model DEHM. The value for a street is for the kerb side with the highest annual mean concentration. The names and numbers for the streets are shown in Table 3.5.

Pollution with NO2 in Copenhagen 2010. The regional differences are clearly connected with traffic density. Source: The Danish Air Quality Monitoring Programme. Annual Summary for 2010

FIGURE 2.1 ANNUAL MEAN TEMPERATURE IN DENMARK 1873-2004 IN °C

Source: Danish Meteorological Institute



The temperature development 1870-2010 in Denmark. Source: Denmarks Fourth National Communication on Climate Change Under the United Nations Framework Convention on Climate Change, 2005

Globalization

Climate change is obviously a global challenge, and it reminds us that almost no important environmental questions are restricted to local or national levels. The time is past, when slogans as *Not In My Back Yard* (relocation of waste) or *One Man's Solution is Another Man's Pollution* (very tall chimneys) could be considered as relevant. At least, sine the publication of the iconic picture (called *Blue Marble*) of Earth taken from Apollo 17 in December 1972, the notion has become universal that we have only got one common globe to share.

In general, traditional rural communities were not self-sufficient. Stone-age artisans traded semi-finished stone products to Central Europe, and long-distance exchange of goods across natural barriers that later became national borders has always been widespread. Both in distance and quantity, however, modernity has involved global interrelations with far-reaching environmental consequences. So, material products, energy carriers and polluting outlets are increasingly being exchanged.

Earth as seen from Apollo 17 in 1972, called Blue Marble. Source: wikipedia.org.

This exchange effectively obscures the actual impact of different societies upon the environment, as energy flows, material consumption, and pollution is being geographically de-centered. Danish energy consumption and pollution are two examples of the difficulties of determining real loads exactly.

As mentioned previously, the face consumption of energy has been almost stagnating for some thirty years but imports of goods processed abroad represent a considerable supply of 'hidden energy'. So, de-industrialization in the form of relocation of heavy energy-consumers helps creating a 'green energy image' for Denmark. And an increasing Danish consumption of consumer goods is now produced in the Third World where environmental protection and provisions of health and safety of the workforce is leaves much to be desired compared with the strict regulation in the west.

It is therefore, clearly imperative to develop new methods for global environmental governance. Such methods, however, are not easily found as for instance the UN is politically no stronger than its strongest member states allow it to be. So instead of direct global governance, attempts are being made to hand over vital control to the invisible hand of international commerce. Yet, nothing really suggests that e. g. trading CO_2 quota is able to provide a full-scale response to climate change.

Ideas

When the most basic biological needs have been fulfilled, most humans appear to require to be assured that the world actually is such as they perceive

it. Some scientists call this notion 'ontological certainty'. Mental and ideological approaches to the man-environment relationship have very much to do with this kind of maintaining or reproducing such a certainty. And not so rarely with collective self-delusions.

So, awareness of environmental problems does not by itself lead to collective action. Inherent in western (and Danish) culture are, however, some traces of values and norms that oppose the biblical 'license to dominate' ("*Be fruitful and multiply, and fill the earth and subdue it; and have dominion over the fish of the sea and over the birds of the air and over every living thing that moves upon the earth*", Genesis 1:26-28), which is often used to summarize the Jewish-Christian tradition's view on human relation to the environment.

One wing of environmental advocacy originates from church groups venerating the providential care for all God's creatures that is also part of the christian tradition. Others from a deep-seated anti-modernity stemming from various hippie-movements more or less influenced by New-Age religiousness. And still others have their basis in a more politically framed anti-capitalism. Denmark, however, has never had a proper Green Party.

Different ideas about the human-environment relationship are, naturally, distributed in society according to certain social distinctions. But such distinctions are not necessarily easily defined. Firstly, however, life styles appreciating environmental vulnerability have a tendency to be more costly than ordinary western life. So, high income appears for many to be a necessary precondition for a 'sustainable life.

Secondly, in a Danish context there seems to be some systemic differences between urban and rural cultures that have achieved societal consequences with regard to dominant environmental ideals and discourses following the twentieth-century demographic displacement from the countryside towards city life.

This conflict became very distinct when hypoxia of coastal water caused by nutrients was heavily debated. Town dwellers were confident that it was caused by excessive use of Nitrogen in agriculture, whereas farmers blamed discharge of Phosphorus from industry and households. If It was, in fact, the combination of both that caused an extensive bloom of algae.

Neither the economic nor the urban-rural distinction should, however, be ex-

aggerated. Engagement in environmental matters appears to rely on personal background and determination more than anything else.

Action

Environmental governance unfolds in an intersection of different interests and organizations, and much action is, in fact, driven 'from below' rather than a result of political decisions. In this respect, the history of the Danish environmental movement shares the main characteristics with other western countries.

The first genuinely environmental movement, *The Danish Society for Nature Conservation*, was founded in 1911. It combined a struggle for nature conservation inspired from similar movements in USA and Germany with protection of the outdoor interests of an expanding urban population. In its early activities, however, it sometimes collided with more unambiguous conservation objectives promoted by natural scientists. So, the matter of public access to picturesque landscapes or ancient monuments remained at the forefront of the society's work for generations. Still, public access in the countryside remained a hot political topic for decades. So, privately owned forests were not opened to public access until the law was revised in 1969.

Logo from 1976 for the Danish organization against nuclear energy (OOA) that was later used all over the world.

In the late 1960s, a new kind of non-governmental environmental organization emerged. Political activism that so far had mainly been directed against the war in Vietnam and the general cold-war arms-race was suddenly focused on the environment as a group of students in 1969 formed the movement NOAH (that later became a part of the international F*riends of the Earth*). Later movements against nuclear and for renewable energy appeared as did

international movements such as Greenpeace. And gradually the far wider reaching Danish Society for Nature Conservation also adapted a more critical approach to general environmental issues.

Until the 1970s, various aspects of environmental politics fell under a number of ministries and state agencies. But in 1971, a *Ministry of Pollution Control* was established, and two years later it changed its name to *Ministry of the Environment*. An expression of the realization that the necessary politics were not restricted to merely controlling pollution. The impact of the ministry, however, has since then been deeply dependent on the personal political power of each minister.

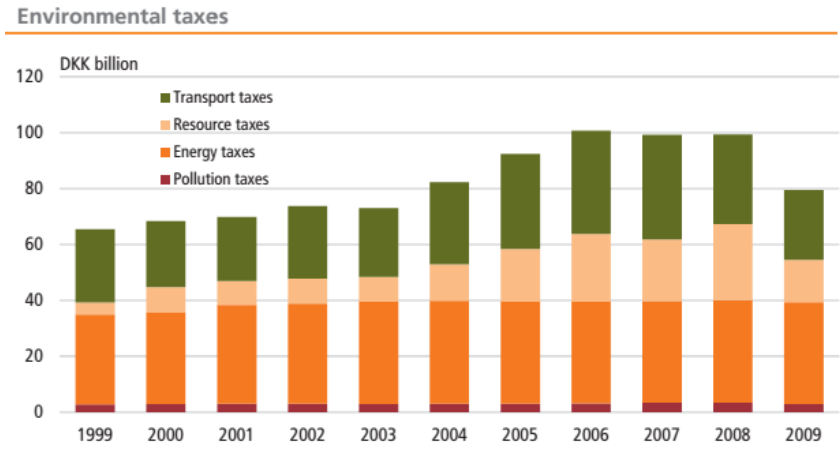
In 1973, the parliament passed the first *Environmental Protection Act*, but naturally this was not the first Danish legislation on the environment. One could argue that the Forest Conservation Act of 1805 actually prescribed sustainable forestry; in the 1850's health regulations were issued to resist further outbreaks of Cholera; in 1860, hunting certain endangered species was banned; and in 1917, the first legislation on landscape conservation followed shortly after the foundation of *The Danish Society for Nature Conservation*.

So, in the 1970's environmental issues achieved a permanent position on the political agenda, and this was new. Since then, the scope and impact of legislation have increased, but legislation has clearly not been the only kind of state regulation of the environmental field. Today, further regulation takes place e. g. through the use of targeted environmental taxation, primarily consisting on taxes on energy consumption, transportation and the handling of solid waste and waste water.

Further, environmental regulation is no longer solely executed by state (or municipal) authorities. UN conventions and EU regulations today form the framework for almost all national enterprise in the environmental policy field. Denmark, in this respect prefers to see itself as the environmental 'top girl' in the EU. But in a number of specific cases this is far from being true. For instance, the Danish implementation of the Water Framework Directive from 2000 is remarkably incomplete.

There are, however, other agents in the environment than political movements and institutions. Ordinary producers and consumers play a vital role, which is not so surprising as they are also the primary causes of environmen-

tal challenges. So, slight changes in production procedures and consumer behavior can have a considerable impact when aggregated to a societal level.



Taxation used as environmental driver. Source: Statistical Yearbook 2013.

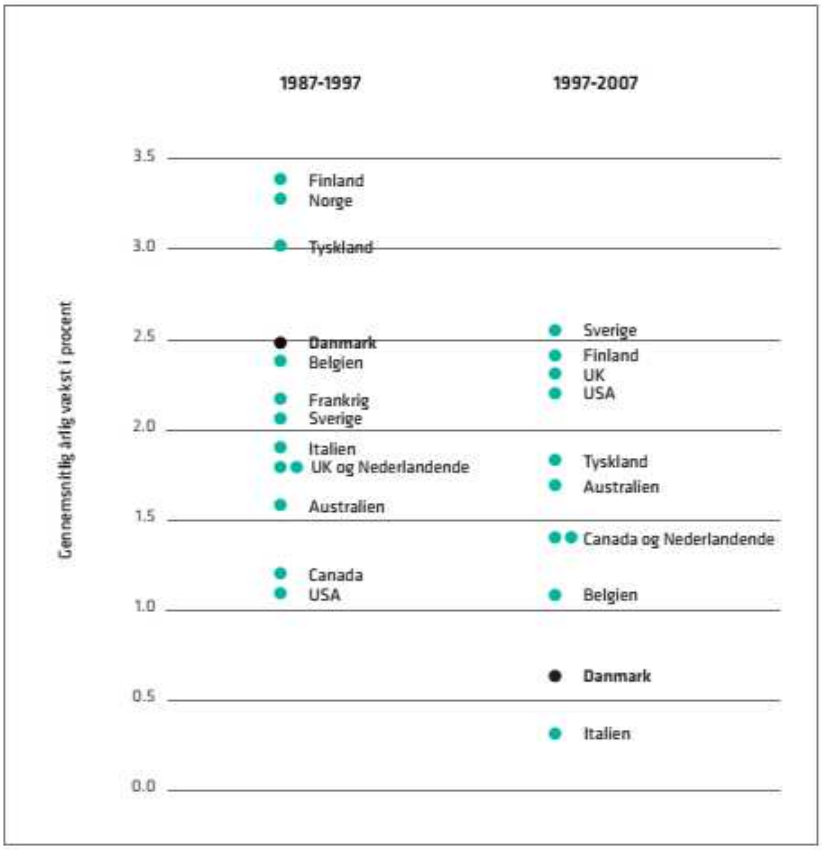
Since the 1980s an increasing number of Danish farmers has, for instance, engaged in so-called organic farming. In 2011, 2670 farms (7 % of all farms) bred 5 % of all farm animals and cultivated 6 % of the total arable. The share of organic food in some categories, however, is considerably higher. Most significantly, one-third of the entire consumption of milk is today organic. This of course, has only been possible because a corresponding number of consumers has been willing to pay a higher price in order to avoid pesticides and GMOs, and to improve animal welfare.

Conclusion: Growth, the human body, and the prospects for a sustainable future

In the light of our present global, financial crisis, many environmental economists have pointed out that continued and equitable quantitative material growth is outrageously unrealistic. But since the 1960s, the annual Danish increase in GDP has slowed down (as it has all over the western world). So, maybe some kind of de-growth economy might not be something that we have to decide about at all. We already have it!

Meanwhile, however, most traditional economists strive to reinstate economic growth as the driver of society, and they anxiously observe how the Danish productivity stagnates or even falls in these years. Measured in GDP, the out-

put per work hour in Denmark is only 89% of what it is in the US, and in average Danes work only 1500 hours a year (compared with Americans' 1700).

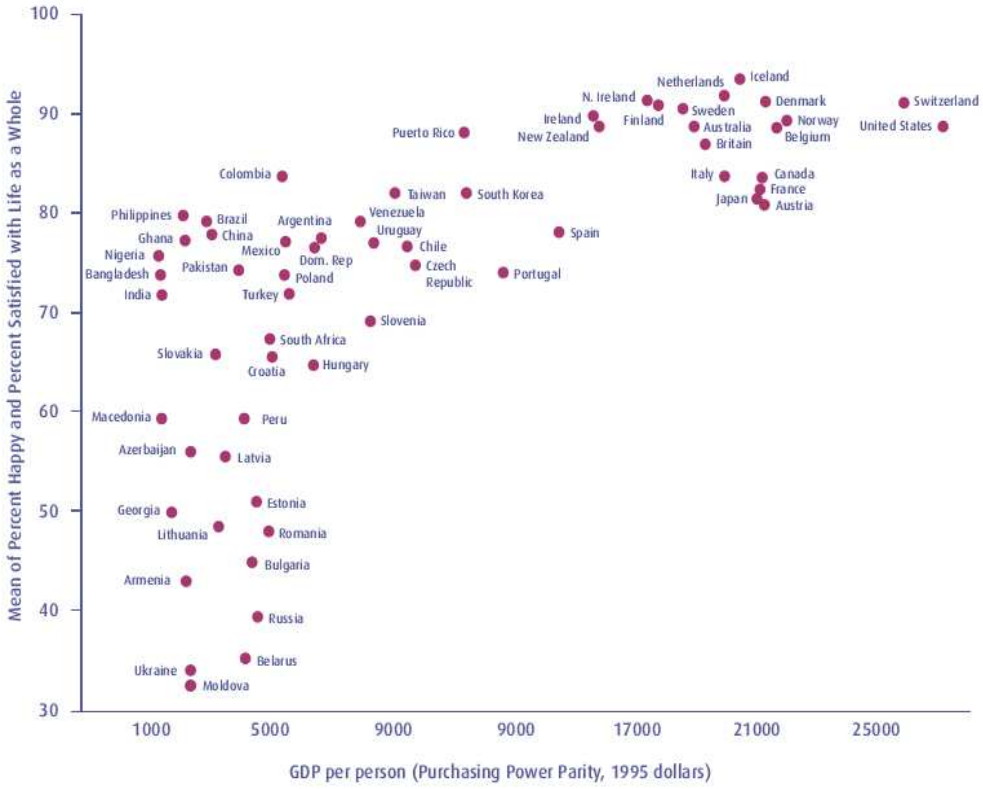


Relative annual increase (%) in working productivity in different countries and compared in two decades. Denmark's drop is remarkable. Source: Produktivitet i Danmark 2011

Naturally, a wide range of factors influences such figures: The predominant kinds of production, the level of automation, female labor-force participation, and the extent of state welfare provisions to name a few. But the impression hangs on that Danes for one reason or other have reached a limit. A limit of exertion that might as well be explained by bodily and mental stress as by an increased cultural acceptability of idleness. Which explanation to choose has much to do with personal political beliefs. But it is evident, that the richer a basically equitable society grows, the less important for the individual continued economic growth becomes.

Denmark (and the entire modern world) might have reached a historical cross-road. Should we continue to pursue reinvigorated productivity in order

to ensure continued growth despite the fact that the country is already consuming energy, materials and outlet capacity far beyond its global share? Or should the target be prosperity rather than growth.



Happiness and average annual income. Puerto Rico with only half the BNP of Denmark appears to have an equally happy population. Source: Worldwatch Institute, State of the World 2008.

If we consider prosperity also to be something subjective that can be deduced from people's happiness with their own life, there is strong evidence that prosperity has much to do with societal equity – but not so much with wealth. So maybe, a sustainable future is feasible without a terrifying collapse. The end is clear (hopefully rather than 'near'), but what are the means?

A few suggestions for further reading

Andrew Jamison (ed.): *The making of the New Environmental Consciousness. A Comparative Study of the Environmental Movements in Sweden, Denmark and the Netherlands*, Edinburgh 1990

Bent Sørensen: *A History of Energy. Northern Europe from the Stone Age to the Present Day*, earthscan 2012

Christian Hey: *EU Environmental Policies: A short history of the policy strategies*, EU Environmental Policy Handbook III, 2005

Denmark in Figures 2013, Statistics Denmark 2013, (http://dst.dk/en/Statistik/Publikationer/VisPub.aspx?cid=17953)

Energy, transport and environment indicators, Eurostat 2012

Kaj Sand-Jensen, Nikolai Friberg & John Murphy (editors): *Running Waters. Historical development and restoration of lowland Danish streams*, National Environmental Research Institute, 2006

Peter Munk Christiansen (ed.): Governing the Environment: Politics, Policy, and Organization in the Nordic Countries, *Nord* 1996:5

Statistical Yearbook 2013, Statistics Denmark 2013

Water supply in Denmark, Jens Stockmarr (ed.), Geological Survey of Denmark and Greenland (GEUS) 2009

Some relevant web resources

http://dce.au.dk/en/

http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/

http://statistikbanken.dk/

http://www.mst.dk/English/

http://www.oecd.org/statistics/